

CLAIMS

We claim:

1. A fluid dynamic bearing system comprising:
 - a journal defined between a shaft and a sleeve, wherein the shaft and the sleeve are positioned for relative rotation;
 - a fluid recirculation passageway including a sleeve passageway defined within the sleeve and having a thrust plate bearing passageway defined between the sleeve and a thrust plate, the sleeve passageway in fluid communication with the thrust plate bearing passageway, the thrust plate extending radially from the shaft, wherein the sleeve passageway and the thrust plate bearing passageway are in fluid communication with the journal at separate locations, the sleeve passageway joining the journal at a location defining a journal plenum, wherein the fluid recirculation passageway is biased for creating an asymmetric pressure gradient and substantially circulating the fluid about the journal, the sleeve passageway and the thrust plate bearing passageway, air being purged from the fluid; and
 - a shield, affixed to one of a stationary component and a rotatable component, defining a reservoir with the sleeve, wherein a recirculation plenum is defined by a junction joining the reservoir, the sleeve passageway and the thrust plate bearing passageway, wherein the reservoir includes a fluid seal.
2. The fluid dynamic bearing system as in claim 1, further comprising spiral grooves defined on the thrust plate for generating pumping pressure to drive fluid recirculation and to pump fluid from the thrust plate bearing passageway toward the shaft, into the journal bearing, and beyond a journal grooving apex, when the shaft and the sleeve are in relative rotational motion.
3. The fluid dynamic bearing system as in claim 1, further comprising an outer diameter gap defined between the shield and an outer diameter of the thrust plate, the outer diameter gap joining the recirculation plenum junction, wherein the outer diameter gap includes a grooved pumping seal (GPS) for establishing outer diameter gap sealing stiffness and for generating

pressure substantially equivalent to the pressure located at the recirculation plenum, when the shaft and the sleeve are in relative rotational motion.

4. The fluid dynamic bearing system as in claim 1, wherein the fluid seal comprises a centrifugal capillary seal defined between the shield and the sleeve, the shield and the sleeve having surfaces relatively tapered and converging toward the recirculation plenum, a meniscus formed between the tapered surfaces, and wherein the fluid in the reservoir is forced toward the recirculation plenum by centrifugal force, when the shaft and the sleeve are in relative rotational motion.

5. The fluid dynamic bearing system as in claim 1, wherein the reservoir is structured for holding up to 2.5 mg. of fluid.

6. The fluid dynamic bearing system as in claim 1, further comprising axial channels on at least a portion of an inner surface of the shield substantially extending from the recirculation plenum, and along the reservoir, for allowing air within the fluid to move along the channels and be purged from the fluid, and for retaining fluid.

7. The fluid dynamic bearing system as in claim 1, further comprising a fill-hole defined within the shield, wherein a meniscus is positioned between the fill-hole and the fluid in the reservoir, the fill hole making an angle with a surface of the shield.

8. The fluid dynamic bearing system as in claim 1, wherein the shaft is affixed to a base and to a top cover plate, and the sleeve rotates relative to the shaft.

9. The fluid dynamic bearing system as in claim 1, wherein an engagement interface of the thrust plate with a base ranges from 3 millimeters to 5 millimeters, for dynamic parallelism.

10. The fluid dynamic bearing system as in claim 1, wherein the shield is positioned for serving as a travel limiter to the sleeve.

11. The fluid dynamic bearing system as in claim 1, further comprising a symmetrical grooving pattern included on a portion of the sleeve adjacent to the shaft comprising one of a herringbone pattern and a sinusoidal pattern for providing radial stiffness substantially focused at an apex of the grooving pattern within the journal.

12. The fluid dynamic bearing system as in claim 1, further comprising an asymmetrical grooving pattern on an end of the shaft wherein the journal plenum is positioned between the asymmetrical grooving pattern and the thrust plate, for providing radial stiffness substantially focused at the asymmetrical grooving pattern apex, and for generating pressure substantially equivalent to the pressure located at the journal plenum.

13. The fluid dynamic bearing system as in claim 1, further comprising a variable journal gap having a larger gap substantially adjacent to the journal plenum for providing asymmetric journal pressure distribution wherein lower pressure is located at the journal plenum and adjacent to the journal plenum, and for reducing power consumption at the journal plenum.

14. The fluid dynamic bearing system as in claim 1, further comprising a diamond-like carbon (DLC) strip on at least one of an end of the shaft wherein the journal plenum is positioned between the DLC strip and the thrust plate, and a sleeve adjacent to a relatively rotating shield, for minimizing particle generation during any contact when the shaft and the sleeve are in relative rotational motion.

15. A spindle motor for withstanding shock comprising:

a journal defined between an inner component and an outer component, wherein the inner component and the outer component are positioned for relative rotation;

a fluid recirculation passageway including a first fluid passageway defined within the outer component, the first fluid passageway in fluid communication with a second fluid passageway, the second fluid passageway defined between the outer component and a radial member extending

radially from the inner component, wherein the first fluid passageway and the second fluid passageway are in fluid communication with the journal at separate locations;

means for creating an asymmetric pressure gradient to circulate fluid and to purge air in the fluid, wherein the fluid substantially circulates about the journal, the first fluid passageway, and the second fluid passageway;

a shield, affixed to one of a stationary component and a rotatable component, defining a reservoir with the outer component, wherein a recirculation plenum is defined by a junction joining the reservoir, the first fluid passageway and the second fluid passageway; and

means for sealing the reservoir.

16. The spindle motor as in claim 15, wherein:

means for creating the asymmetric pressure gradient comprises spiral grooves defined on the radial member to generate pumping pressure to drive fluid recirculation and to pump fluid from the second fluid passageway toward the inner component and into the journal, when the inner component and the outer component are in relative rotational motion; and

means for sealing the reservoir comprises at least one of a capillary seal defined between the shield and the outer component, and spiral grooves on the radial member adjacent to an outer diameter gap defined between the shield and an outer diameter of the radial member, the outer diameter gap joining the recirculation plenum junction.

17. The spindle motor as in claim 15, wherein the reservoir is structured to hold up to 2.5 mg. of fluid.

18. The spindle motor as in claim 15, further comprising axial channels on at least a portion of an inner surface of the shield substantially extending from the recirculation plenum and along the reservoir, to allow air within the fluid to move along the channels and be purged from the fluid, and to retain fluid.

19. The spindle motor as in claim 15, further comprising a fill-hole defined within the shield, wherein a meniscus is positioned between the fill-hole and the fluid in the reservoir, the fill hole making an angle with a surface of the shield.

20. The spindle motor as in claim 15, wherein the inner component is affixed to a base and to a top cover plate, wherein the outer component rotates relative to the inner component.

21. The spindle motor as in claim 15, wherein an engagement interface of the radial member with a base ranges from ranges from 3 millimeters to 5 millimeters, for dynamic parallelism.

22. In a spindle motor having a journal defined between an inner component and an outer component, the inner component and the outer component positioned for relative rotation, a method comprising:

defining a first fluid passageway within the outer component, the first fluid passageway in fluid communication with a second fluid passageway, the second fluid passageway defined between the outer component and a radial member extending radially from the inner component, wherein the first fluid passageway and the second fluid passageway are in fluid communication with the journal at separate locations;

creating an asymmetric pressure gradient to substantially circulate fluid about the journal, the first fluid passageway and the second fluid passageway, and to purge air from the fluid;

forming a reservoir defined between a shield and the outer component, and sealing the reservoir, wherein a recirculation plenum is defined by a junction joining the reservoir, the first fluid passageway and the second fluid passageway; and

affixing the shield to one of a stationary component and a rotatable component.

23. The method as in claim 22, wherein creating an asymmetric pressure gradient comprises forming spiral grooves on the radial member to generate pumping pressure to drive fluid recirculation and to pump fluid from the second fluid passageway toward the inner component and into the journal, when the inner component and the outer component are in relative rotational motion.

24. The method as in claim 22, further comprising defining an outer diameter gap between the shield and an outer diameter of the radial member, the outer diameter gap joining the recirculation plenum junction, and sealing the outer diameter gap by employing spiral grooves on the radial member adjacent to the outer diameter gap, to establish outer diameter gap sealing stiffness when the inner component and the outer component are in relative rotational motion.

25. The method as in claim 22, wherein sealing the reservoir comprises employing a centrifugal capillary seal defined between the shield and the outer component, the shield and the outer component having surfaces relatively tapered and converging toward the recirculation plenum, fluid being retained in part by a meniscus formed between the tapered surfaces, the fluid in the reservoir being forced toward the recirculation plenum by centrifugal force when the inner component and the outer component are in relative rotational motion.

26. The method as in claim 22, further comprising structuring the reservoir to hold up to 2.5 mg. of fluid.

27. The method as in claim 22, further comprising forming axial channels on at least a portion of an inner surface of the shield substantially extending from the recirculation plenum, and along the reservoir, to allow air within the fluid to move along the channels and be purged from the fluid, and to retain fluid.

28. The method as in claim 22, further comprising defining a fill-hole within the shield, wherein a meniscus is positioned between the fill-hole and the fluid in the reservoir, the fill hole making an angle with a surface of the shield.

29. The method as in claim 22, further comprising affixing the inner component to a base and to a top cover plate, wherein the outer component rotates relative to the inner component.

30. The method as in claim 22, further comprising engaging the radial member with a base, wherein the engaging interface ranges from 3 millimeters to 5 millimeters, for dynamic parallelism.